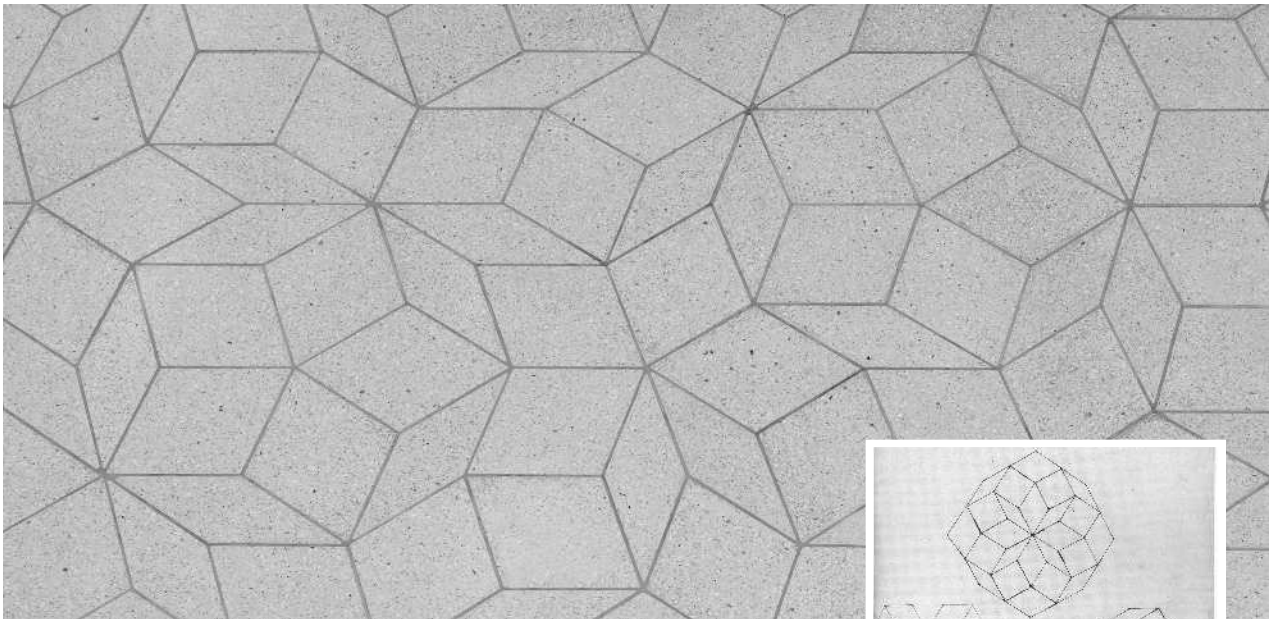
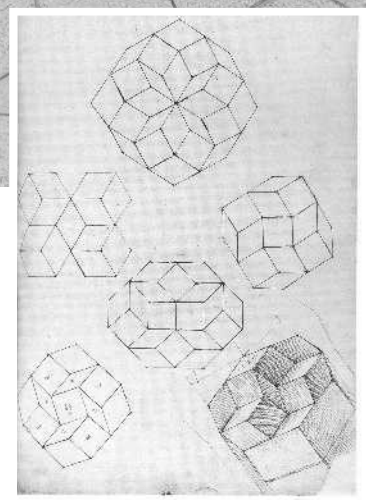
SCIENCE IN CULTURE

A trick of the tiles

Penrose tiling is realized on a huge scale in Perth to give a perceptual feast for the eyes.



TERRACE PHOTOGRAPHERS



Martin Kemp

Geometry in Western art predominantly involves space and proportion. But in other cultures, most notably Islamic, Chinese and Japanese, artistic geometry flowered most conspicuously in flat patterns, above all in the invention of striking tessellations in tiling, mosaics and textile designs. The trick was to invent a repeated geometric pattern of considerable complexity without generating 'gaps' that had to be arbitrarily filled.

Working with straight-edge and compass, over the centuries geometer-artisans accumulated an astonishing array of periodic patterns, including many of the types later defined in mathematical theory. The basic principles involved in such tessellations — that they are possible only with one-, two-, three-, four- or six-fold symmetries — held good until 1974, when the mathematician Roger Penrose from the University of Oxford unveiled a 'gap-free' tiling based on five-fold symmetry. The two types of tile are the 'kite' and the 'dart', obtained by intersecting a single rhombus with angles of 72° and 144°, respectively. As it happens, the ratio of the long edges to the shorter is the golden ratio.

Later, Penrose demonstrated that a simpler pair of tiles in the form of fat and thin rhombuses (or diamonds) also generate five-fold symmetry in an aperiodic pattern. In other words, from the five equivalent directions from each angular point, the pattern does not repeat itself — though instinctively we feel that it should if we look hard enough.

This more recent Penrose tiling has been cleverly used in the floor of the atrium of the new Molecular and Chemical Sciences Building at the University of Western Australia in Perth. The floor (see above) was the idea of Professor David Kepert, then head of the School of Chemistry, and his colleague Frank Lincoln, and the tiling was developed by the architect Gus Ferguson. Starting from a central five-pointed star midway between the lift and the stairway opposite, Ferguson used two types of locally manufactured concrete tile in the form of fat and thin rhombuses to develop the five-fold symmetry across the entire floor.

The result is a strange spider's web of lines, which, although composed of just two simple repeated shapes, presents us with a perceptual and cognitive field replete with possibilities. As with the patterns designed over the centuries, its fascination transcends the purely mathematical. Looking at such arrays, we are perceptually tuned to tease out coherences that go beyond seeing the paired shapes.

When staring at the patterns for any length of time, a deep-seated perceptual proclivity comes into play. We can hardly avoid discerning shapes compounded from clustered elements, discovering five-pointed stars and bilaterally symmetrical polyhedra, plotting zigzag strands and so on. Almost inevitably, spatial instincts also come into play, although none of the 'sides' of the perceived 'bodies' converges to notional vanishing points. We can, for instance, play Necker cube-type games with apparent octagons, and facet the surface into a kind of cubist medley of receding and advancing planes.

Authors of earlier tiling patterns deliberately enhanced the implicit spatial thrusts by infilling the tiles with varied colours and tones in regular repeats, and by alternately interweaving the thin bands that demarcate the patterns. This effect is seen clearly in the 1524 doodling of the German artist Albrecht Dürer, one of whose repeated patterns of flat rhombuses and cubes was thrown suddenly into paradoxical relief through the addition of hatched shading (see above, inset). We instinctively tend to do the same in our minds, even where the pattern frustrates perspectival coherence.

It is easy to imagine why the designer of the Perth floor did not shade or colour the tiles. The spatial cacophony that would result with an aperiodic pattern on such a scale would have been jarring. But the waiting visitor or someone pausing on one of the landings can easily play the spatial game. Indeed it is hard to avoid doing so.

Martin Kemp is professor of the history of art at the University of Oxford, Oxford OX1 1PT, UK, and is the author of *Leonardo* (Oxford University Press, 2004).